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Effect of organic amendments on microbial population and enzyme activities of soil

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ABSTRACT

The organic sources FYM, sludge, poultry manure, fresh cow dung and leaves & twigs of Lantana camera have potential as soil amendments and can augment microbial population and enzyme activities. Sludge has the maximum capacity to increase population of fungi (21cfu×10^4 /g soil) and actinomycetes (30cfu×10^5/ g soil) both at 45 DAI followed by FYM. FYM exibits their potential to raise bacterial population (47 cfu×10^6 /g soil) at 45 DAI. Sludge follows FYM in regards to bacterial population. FYM elaborates maximum dehydrogenase activity (24µg TPF g^{-1} soil day^{-1}) at 45 DAI followed by fresh cow dung. Sludge induces maximum urease activities (364 µg urea hydrolyzed g^{-1} soil h^{-1}) at 45 DAI. So far as phosphatase activity is concerned, it shows maximum under poultry manure (49mmol p-nitrophenol g^{-1} soil h^{-1}) at 30 DAI followed closely by fresh cow dung (48mmol p-nitrophenol g^{-1} soil h^{-1} also at 30 DAI).

***Keywords**:* Dehydrogenase, incubation, phosphatase, microbial biomas, urease.

Keeping soil health intact for sustained production had been the prime concern of agricultural science and shall ever remain so till any source other than farming is searched out as a source of human nutrition. The term soil health is a composite nomenclature comprising physical, chemical and biological properties of soil. The various soil properties too are closely inter related and inter dependent the interplay of which is the ultimate parameter of productivity of soils. The soil biological attributes are also responsible for determination & maintenance of physical properties of soil. The physical properties of soil in its own turn control not only the quantum of chemical properties, but also the rate of their release and availability to plants essential for metabolic processes. Thus, it may be said that soil biology is the door to maintenance of soil health.However, the microbial biomass and their activities in soil may fluctuate due to different soil management practices (Doran, 1980; Handrix *et al.* 1986) as well as spatio-temporal variation (Hodge, Robinson and Fitter, 2000). They observed that the soil microbial community also changes with season in alpine ecosystems. This indicates the difficulty in fully understanding such competition without considering the spatio-temporal context.

Traditionally the sources of organic matter or carbon in the soils squarely rested on application of FYM or compost, incorporation of plant residues in soil either in the forms of green manuring or incorporation of roots and stubbles in the soils or through the leaves of crops falling on the ground and getting mixed up in the top soil as humus. Mandal *et al.* (2013) has proved that integration of inorganic, organics and bio-fertilizers can producer 50-92% more yield in aonla. Ironically the production of the most important source of organic matter in soil, the cow dung has greatly reduced as a result of tillage done by tractors and tillers instead of bullocks, introduction of exotic and cross breed of cows having much higher milk yield potential which reduced the number of herds reared up and lastly use of cow dung as a source of fuel especially in rural areas. Thus, one will have to look towards non-traditional sources of organic matter for maintenance of population of bacteria, fungi, actinomycetes earthworm etc. in the soil. Positive relationships between relevant soil properties and enzyme activities suggest that addition of organic matter increased microbial activity/ diversity and turnover, which subsequently leads to greater enzyme synthesis and accumulation in the soil matrix. (Dinesh *et al*., 2000). The situation referred to above has necessitated looking towards sources like sludge, poultry manure and weeds in abundance like *Lantana camara.* If non-traditional sources which are available in abundance prove to be a source for multiplication of the living world population in soils, it may be a potent tool towards sustainable agriculture. The objective of this study was to estimate the effect of different organic amendments at different incubation periods on microbial population extent and enzyme activity in soil.

MATERIALS AND METHODS

A pot experiment was conducted in the department of soil science and agricultural chemistry, Institute of agricultural sciences, BHU, Varanasi during 2009 –

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2010. The soil collected for the pot experiment was from the research farm of BHU. The soil of the University research farm has been formed due to alluvium deposits in the gangetic plane and is predominantly illite, quartz and feldspar minerals. Gupta *et al. (2002)* also reported that Gangatic plains soils are primarily calcareous and micaceous alluviums with sandy loam to loam in the upper reaches becoming finer textured in the distal plains close to the mouth of the river systems.

Five organic amendments *viz.* FYM, poultry manure, fresh cow dung, sludge, *Lantana camara* and a control were tested in four replications under completely randomise block design. According to Sharma S. N., (2012) CRD is appropriate when the experimental material is limited & homogeneous, such as the soil in the pot culture experiments. Kumar *et al*. (2012) reported that cow dung (usually combined with soiled bedding and urine) is often used as manure (agriculture fertilizer). Each pot was filled up with 2 kg of pulverised soil taken from a single lot of even characteristic. In these pots the six organic amendments were added to each pot @ 10 g symbolising their doses at the rate 10 t ha^{-1}. The soils thoroughly mixed with their respective amendments were potted. The pots were kept for 45 days to observe periodic incubation at an interval of 15 days. During this period pots were kept moist by striking water so as to make them resemble with any cropped field having moisture adequate to full fill the needs of crop plants. Water holding capacity during the incubation period was 36 %. The pots were kept weed free providing weeding as and when observed essential. Soil samples from these pots were taken out at an interval of 15 days up to 45 days after potting. The soil samples drawn were analysed for various properties of different organic amendments and enzyme activities in soil.

RESULTS AND DISCUSSION

Microbial population

Application of an organic amendments under study were instrumental in raising the population of bacteria, fungi and actinomycetes in all the periodical observations at the interval of 15 days and up to 45 days after incubation. Application of FYM application induced rise in bacterial population (Table 1) whereas sludge was significantly the most effective amendment in raising population of fungi (Table 2) and actinomycetes (Table 3). These two organic amendments (sludge & FYM) always figured in the top two places following one another. *Lantana camara* had the least values in all the periodical observations, but still it had higher values than the control showing its definite impact in raising microbial population. In case of fungi on all the three days of observations (15, 30 and 45 DAI) and in case of actinomycetes on the 15^{th} and 30^{th} DAI, *Lantana camara* had values statistically comparable with that of the control but its marginally and consistent higher values are an indication of its positive impact even on the fungal and actinomycetes population of soil. The control pots did not show any appreciable change in microbial population in the periodical observation there by demonstrating homogeneity in the environmental condition provided in the entire experimental period.

Considering the effect of organic amendments over the period of incubation, it could be inferred that sludge went on increasing bacterial and actinomycetes population up to 45 DAI. Whereas, FYM showed prolonged impact only in case of actinomycetes population. Actinomycetes population also showed abrupt increase due to application of fresh cow dung and *Lantana camara* from 30^{th} DAI to 45^{th} DAI. This might have been the result of longer period needed for decomposing these organic amendments. It was only

Table 1: Effect of organics on population of bacteria (cfu × 10^7 g^{-1} oven dry soil) at different days after incubation

Organics	Incubation periods (days)		
	15	30	45
Control	2.6	2.5	2.7
FYM	4.5	4.7	4.7
Sludge	4.1	4.2	4.6
Poultry manure	3.3	3.5	3.2
Fresh cow dung	3.9	4.1	4.1
Lantana camara	3.1	3.4	3.5
SEm(±)	**0.96**	**1.04**	**1.07**
LSD(0.05)	**2.02**	**2.20**	**2.26**

Table 2: Effect of organics on population of fungi (cfu×10^5 g^{-1} oven dry soil) at different days after incubation

Organics	Incubation periods (days)		
	15	30	45
Control	1.0	1.0	1.1
FYM	1.3	1.5	1.7
Sludge	1.8	2.0	2.1
Poultry manure	1.2	1.2	1.5
Fresh cow dung	1.3	1.5	1.6
Lantana camara	1.2	1.2	1.3
SEm(±)	**0.73**	**0.80**	**0.99**
LSD(0.05)	**1.55**	**1.70**	**2.08**

Table 3: Effect of organics on population of actinomycetes (cfu×10^6 g^{-1} oven dry soil) at different days after incubation

Organics	Incubation periods (days)		
	15	30	45
Control	1.4	1.4	1.4
FYM	2.1	2.1	2.5
Sludge	2.4	2.7	3.0
Poultry manure	1.6	1.5	2.1
Fresh cow dung	1.7	1.7	2.4
Lantana camara	1.6	1.4	1.8
SEm(±)	**1.44**	**1.03**	**0.80**
LSD(0.05)	**3.03**	**2.16**	**1.68**

in case of poultry manure application wherein an appreciable drop in bacterial population was noted after 30 DAI. Whereas in cases of all other microbes and at all stages of observations the highest values for population of bacteria, fungi and actinomycetes were noted at 45 DAI.

Correlation of organic matter accumulation and the corresponding microbial population is a proven principle as indicated by several research workers (Jenkinson and Ladd, 1981; Gaur *et al.,* 1971; Dinesh *et al.,* 2000). The effectiveness of FYM and sludge in enriching soils with microbes may also be attributed to their higher carbon content, which decomposes at a higher rate (Butarewicz, 2003; Clark *et al*., 1998; Sistani *et al*., 2004; Roberson *et al.,* 2008).

Enzymatic activities

Enzymatic activities as reflected in terms of dehydrogenase activity, phosphatase activity and urease activity increased with application of organic amendments although having their impact to varying degrees. *Lantana camara* was observed to have the least impact amongst various amendments tested. FYM increased dehydrogenase activities which was noted to be the maximum (24 µg TPF g^{-1} soil day $^{-1}$at 45 DAI).The amendment next in order was observed to be fresh cow dung showing a corresponding value of 22µg TPF g^{-1} soil day $^{-1}$at the same stage. In case of all the amendments dehydrogenase activity increased gradually during the periodic observation recording

Table 4: Effect of organics on dehydrogenase activity (µg TPF g^{-1} soil day^{-1}) at different days after incubation

Organics	Incubation periods (days)		
	15	30	45
Control	13	14	17
FYM	17	21	24
Sludge	14	16	20
Poultry manure	13	17	18
Fresh cow dung	16	21	22
Lantana camara	13	15	18
SEm(±)	**0.14**	**0.2**	**0.25**
LSD(0.05)	**0.31**	**0.42**	**0.54**

Table 5: Effect of organics on urease activity (µg urea hydrolyzed g^{-1} Soil h^{-1})at different days after incubation

Organics	Incubation periods (days)		
	15	30	45
Control	350	356	358
FYM	355	357	359
Sludge	357	363	364
Poultry manure	345	347	349
Fresh cow dung	354	357	360
Lantana camara	353	355	359
SEm(±)	**0.19**	**0.92**	**0.22**
LSD(0.05)	**0.39**	**1.94**	**0.46**

their highest values at 45 DAI (Table 4).The application of sludge which was comparatively less effective in increasing dehydrogenase and phosphatase activities was significantly the most effective in influencing urease activity (364 µg urea hydrolyzed g^{-1} Soil h^{-1} at 45 DAI). The organic amendments increased urease activity also consistently up to 45 DAI as in case of dehydrogenase activity (Table 5). FYM was the amendment next in order to follow sludge in descending order. So far as phosphatase activity was concerned it was fresh cow dung and poultry manure which influenced it the most. In case of all the organic amendments the values of phosphatise activity were maximum at 30 DAI (Table 6), but the decline thereafter were most abrupt in case of FYM, sludge and poultry manure. Phosphatase activity was noted to be the maximum under poultry manure at 30 DAI (49 mmol p-nitrophenol g^{-1} soil h^{-1}). Juma and Tabatabai (1977) and Tarafdar and Jungk (1987) reported that root exudates and manure can stimulate phosphatase activity by providing soil microorganisms with sources of C, N, and P a negative-feedback mechanism partially controls phosphomonoesterase activity, and enzyme inhibition can occur when high levels of inorganic P are present (Nannipieri *et al.,* 1978, 1990; Olander and Vitousek, 2000; Colvan *et al.,* 2001).

Organic phosphorus in soil can comprise 30 to 70 percent of the total phosphorus content. Hydrolysis of these organic phosphorus compounds is essential for uptake by plants and microorganisms, which is correlated by alkaline phosphatase. The results obtained under this investigation get able support in the works of (Goyal *et al.,* 1993; Pascual *et al*., 1998; Sainju *et al.,* 2003). They observed that incorporation of organic amendments to soil influences soil enzymatic activities because the added material may contain intra- and extracellular enzymes and may also stimulate microbial activity in the soil. It was concluded that application of organic amendments improve soil quality, increase its organic matter content and improve biological properties. FYM application appeared to be better in improving microbial population (bacteria, fungi and actinomycetes), enzymatic activities (dehydrogenase, urease and phosphatase).

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Table 6: Effect of organics on phosphatase activity (mmol p-nitrophenol g^{-1} soil h^{-1}) at different days after incubation

Organics	Incubation periods (days)		
	15	30	45
Control	32	38	32
FYM	41	44	37
Sludge	36	38	33
Poultry manure	41	49	45
Fresh cow dung	42	48	47
Lantana camara	33	36	35
SEm(±)	**0.23**	**0.17**	**0.35**
LSD(0.05)	**0.50**	**0.37**	**0.74**

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